A Field Manual of Scientific Protocols for Steelhead Redd Surveys within the Upper Columbia Monitoring Strategy

2008 Working Version 1.0

June 30, 2008

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Published by:

Terraqua, Inc.
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Prepared for and funded by:
Bonneville Power Administration's
Integrated Status and Effectiveness Monitoring Program

ACKNOWLEDGEMENTS

This document was prepared for and funded by the Bonneville Power Administration's Integrated Status and Effectiveness Monitoring Program. Many thanks go to all those who contributed to and reviewed this field manual, including Justin Call, U.S. Forest Service, Phil Archibald, U.S. Forest Service Entiat Ranger District, and James White, Upper Columbia Salmon Recovery Board.

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Section 1: Introduction

Columbia River Basin anadromous salmonids have exhibited precipitous declines over the past 30 years, with several populations now protected under the Endangered Species Act (ESA) (Schaller et al. 1999; McClure et al. 2002). A comprehensive monitoring strategy needs to be implemented to reduce the uncertainties surrounding the declines and the actions required to reverse this trend. Data collected from current and historical monitoring programs are generally not adequate or reliable enough for the purposes of ESA assessments and recovery planning (Tear et al. 1995; Campbell et al. 2002; Morris et al. 2002). In addition, monitoring programs for anadromous salmonids in the Columbia River Basin have typically been initiated to evaluate the effects of specific management actions, such as the demographic effects of hatcheries. As such, data are most appropriately viewed at the scale of the subpopulations and populations for which they were derived. However, the ESA requires assessments of species and their habitat at multiple spatial scales – from specific reaches, to subpopulations, populations, and the ESA management unit of Pacific salmon, the Evolutionary Significant Unit (ESU), which is a distinct population or group of populations that is an important component of the evolutionary legacy of the species.

Current monitoring programs for Pacific salmon did not develop as a cohesive design, thus aggregating existing data from a myriad of independent projects creates challenges in addressing these spatially complex questions. These problems arise because information is often not collected in a randomized fashion (Larsen et al. 2004); sampling techniques and protocols are not standardized across programs; and abundance, distribution, population dynamic, and demographic data for species and their habitat is often not available (Tear et al. 1995; Campbell et al. 2002; McClure et al. 2002). As recovery planning has focused more effort on tributary habitat restoration to mitigate for the mortality resulting from the Federal Columbia River Power System (FCRPS) the limitations of historic and ongoing sampling programs have become increasingly apparent.

The Integrated Status and Effectiveness Monitoring Program (ISEMP – Bonneville Power Administration (BPA) project #2003-0017) was created as a cost effective means of developing protocols and new technologies, novel indicators, sample designs, analytical, data management and communication tools and skills, and restoration experiments. These tools are designed to support the development of a region-wide Research, Monitoring and Evaluation (RME) program to assess the status of anadromous salmonid populations, their tributary habitat, and restoration and management actions.

The ISEMP has been initiated in three subbasins: Wenatchee/Entiat, WA, John Day, OR, and Salmon River, ID, with the intent of designing monitoring programs that can efficiently collect information to address multiple management objectives over a broad range of scales. This includes:

• Evaluating the status of anadromous salmonids and their habitat;

• Identifying opportunities to restore habitat function and fish performance, and

• Evaluating the benefits of the actions to the fish populations across the Columbia River Basin.

The multi-scale nature of this goal requires the standardization of protocols and sampling designs that are statistically valid and powerful, properties that are currently inconsistent across the multiple monitoring programs in the region. The Upper Columbia Monitoring Strategy (UCMS, Hillman 2006) is the guiding document under which the ISEMP develops its monitoring and implementation strategies and protocols. The UCMS (Hillman 2006) outlines a monitoring strategy specific to the Upper Columbia Basin that was based on monitoring approaches adopted by the Independent Scientific Advisory Board of the Northwest Planning council (ISAB), Action Agencies/NOAA Fisheries, and the Salmon Recovery Funding Board (SRFB). This approach includes monitoring current conditions (status monitoring), monitoring changes over time at the same sites (trend monitoring), and monitoring the effects of restoration actions on fish populations and habitat conditions (effectiveness monitoring).

Although the UCMS (Hillman 2006) identifies the project area as the Wenatchee, Entiat, Methow, and the Okanogan River subbasins, this and other ISEMP protocols have been implemented as pilot projects in the Wenatchee and Entiat River subbasins. Monitoring in the Okanogan River subbasin is conducted by the Colville Tribe under the Okanogan Basin Monitoring and Effectiveness Plan (OBMEP) using protocols similar to, but differing in some areas, ISEMP protocols. A comprehensive and coordinated monitoring in the Methow River is under development.

This document was created as an internal guide for field practitioners working within BPA's ISEMP. This draft document has been updated and revised for the 2008 field season. The methods described by this protocol are intended to measure the abundance and distribution of steelhead *Oncorhynchus mykiss* redds in the Entiat and Wenatchee subbasins as recommended by the UCMS (Hillman 2006). The ISEMP program has taken an experimental approach to the development of scientific monitoring protocols. Hence, this document is best viewed as a working draft that is subject to change as the ISEMP program adds, subtracts, or modifies portions of these methods. Changes to methods are adopted at the beginning of the field season and adhered to until the next year's manual is completed. However, because another purpose for this document is to prepare for the development of a final field manual when ISEMP is ready to propose standardized monitoring program elements, this manual also serves as a draft template for future ISEMP field manuals. This redd survey protocol is a component of the overall ISEMP, and while it stands alone as an important contribution to the management of anadromous salmonids and their habitat, it also plays a key role within ISEMP as it is built on a standardized format following Oakley et al. (2003) that all of the ISEMP protocols adhere to.

Upper Columbia River (UCR) steelhead, which includes the Entiat and Wenatchee River watershed steelhead, were listed as an endangered species by the National Marine Fisheries Service (NMFS) in 1997. Justification for listing UCR steelhead as endangered was cited as a clear failure of natural populations to replace themselves as a result of genetic homogenization from hatcheries, high steelhead smolt mortality in the hydrosystem, and reduced habitat quality (Busby et al. 1996). The UCMS includes abundance and distribution of salmonid redds as indicators of population health. In an effort to monitor the number of steelhead returning to the Entiat River watershed, the U.S. Forest Service (USFS) initiated annual steelhead redd surveys at index reaches in 1999. These surveys provided the only information specific to natural spawning steelhead in the Entiat River watershed. The locations surveyed have expanded since 1999 to include the Mad River and Roaring Creek sections of the Entiat River downstream of Fox Creek. In 2003, the U.S. Fish and Wildlife Service (USFWS) initiated redd surveys in the main Entiat River with USFWS funding. NOAA-Fisheries began funding the USFWS to conduct expanded main river steelhead redd surveys in the Entiat River in 2005, and has been funding index reach surveys of the Mad River by USFS-Entiat Ranger District since 2006. These surveys have been funded by the ISEMP since 2007. The Washington Department of Fish and Wildlife (WDFW) began conducting limited redd surveys in the Wenatchee subbasin in 2000, funded by Chelan County Public Utility District. These redd surveys were conducted in streams selected for supplementation to determine the efficacy of a supplementation program in increasing the number of natural spawners. The ISEMP began funding the WDFW in 2004 to expand the scope of the surveys to include all tributaries in the Wenatchee subbasin with a significant steelhead spawning population and to ensure surveys are conducted on a weekly basis.

Objectives of the steelhead redd surveys are to:

1) Enumerate steelhead redds within index areas or within random sites.

2) Detect trends of redd abundance and distribution within larger reaches based upon enumeration of steelhead in index areas, and estimate status of redd abundance and distribution within the watershed using random annually selected (GRTS design) sampling sites.

3) Identify steelhead spawning timing in the Entiat and Wenatchee River subbasins.

This manual is designed for quick reference in the field, and is arranged in the order that crews would be generally expected to follow. Detailed descriptions of how to measure indicators have been included to reduce observer variation. It is appropriate to use this manual when performing status/trend monitoring or effectiveness monitoring in the Upper Columbia Basin, although study design requirements for specific effectiveness monitoring projects may require that aspects of these protocols be modified.

Section 2: Sampling Design and Site Selection

This protocol is designed to standardize surveys used to determine abundance and distribution of steelhead redds in the Upper Columbia Basin. The UCMS (Hillman 2006) serves as the primary reference for sampling designs at the basin and subbasin scale. It may be appropriate to modify these sampling designs in order to address specific questions within any particular subbasin of the Upper Columbia Basin.

The UCMS (Hillman 2006) calls for a complete census of fall-spawning anadromous fish redds (e.g., Chinook and sockeye salmon), while for other species (e.g., steelhead and bull trout) redd abundance and distribution is determined from annual sampling of already-established index reaches and in reaches selected using probabilistic sampling (GRTS; see Site Selection Protocol, Moberg and Ward 2008). Distribution indicates the spatial arrangement (e.g., random, even, or clumped) and geographic extent of redds within the basin. To assess changes in spawning distribution, a five-year rotating panel design with 25 reaches per year has been implemented in the Wenatchee River subbasin (see Site Selection Protocol, Moberg and Ward 2008) where a different set of 25 reaches is sampled four times two weeks apart over the survey period each year during the first five years.

Section 3: Steelhead Redd Survey Standard Operating Procedures

References:

Nelle (2007), Archibald and Johnson (2007), Murdoch and Viola (2003), Mosey and Murphy (2002).

Equipment:

See Appendix C.

Concept:

Spawning is thought to begin when water temperatures are near 4.0^0C and generally progresses upstream following favorable water temperatures. Most spawning is thought to be completed by mid-June; however, actual conditions may advance or delay expected spawning. Conducting spring redd surveys can be difficult due to fluctuating discharge, water temperatures, and turbidities so that surveys for steelhead redds may not be made on regularly timed intervals and adjusting surveys to fit environmental conditions may be necessary. It is important that the first survey occurs just prior to the expected onset of steelhead spawning so that subsequent surveys count only newly formed steelhead redds. This should results in zero redds counted during the first survey. Throughout the spawning period investigators conduct at least bi-weekly redd surveys (Gallagher and Gallagher 2005). The survey is complete when no new redds have been detected for two consecutive surveys. Every other week new redds will be counted, mapped, and marked. Identifying specific redd locations by flagging, marking, or GPS is needed to avoid recounting redds during subsequent surveys. Abundance of redds will be reported as the number of redds within a watershed reach or watershed, or as the number of redds per km within each selected watershed. Redd surveys are conducted by two-member teams on foot or by rafting in the spawning areas. Surveys are conducted in a downstream manner, taking care not to disturb spawning fish.

Redds are typically found in areas of down-welling (where water is hydraulically forced into the substrate) and where water depths are >24 cm (Smith 1973) with velocities of 40 to 91 cm/sec (Smith 1973) and substrate diameters range from 0.6 to 10.2 cm (Hunter 1973). The investigator should be familiar with the size of redds or nests produced by other species of fish that may be spawning at the time the surveys are conducted to be able to distinguish between redds of the target species and redds of other species.

Sources of Error and Bias

Gallagher and Gallagher (2005) identified sources of errors or bias when conducting steelhead redd surveys in coastal streams of Northern California. Undercounting errors were controlled for and estimated by flagging and marking of redds. Observations of marked redds to unmarked redds were then compared, where marked redds and unmarked (or new) redds were equally detectable, suggesting that an undercount bias was not a source of error. Furthermore, conducting surveys no more than 14 days apart assured that new redds were not missed, which would also have resulted in an undercount. Although Gallagher and Gallagher (2005) took many detailed measurements of redd size and shape to distinguish between other potential spawning species in Northern California coastal streams, the chances of misidentifying steelhead redds in the Upper Columbia Basin are low due to the lack of other species spawning during the same time period. While Gallagher and Gallagher (2005) did not look at sources of overcounting bias, they suggested that this source of error is controlled for because the protocol contained a redd classification category of ‘test’ or ‘possible’ to be used when surveyors came upon disturbed substrate that looked like a redd but were uncertain if they were redds or channel features. The study also found that observer efficiency in redd detection was significantly associated with stream flow and water visibility ($P < .001$), and were able to use these variables to predict observer efficiency for years during which it was not estimated in the field.

Dunham et al. (2001) assessed the inter-observer variability for bull trout redd surveys in Idaho and identified the sources for inter-observer error. Their study found inter-observer variability to be high in both false counts and errors of omission, although the two error sources tended to cancel each other out. Dunham et al. (2001) and Bonneau and Labar (1997) found that inter-observer variation in redd counts was high regardless of experience and recommended more rigorous and intensive crew training. Training should include the tracking of individual redds over time and tracking of redd accumulation over as much of the spawning season as possible. Inter-observer variability may be much lower in the Upper Columbia Basin than in Oregon and California coastal streams due to the lack of confounding factors (e.g., presence of redds from other species), but continued protocol development and rigorous crew training help reduce inter-observer variability and selected repeat sampling would estimate the inter-observer error. The development and continued practice of consistently measured stream visibility metrics (observed stream clarity or measured turbidity) and stream flow metrics could further improve the reliability of estimates of escapement derived from steelhead redd counts.

<u>Wenatchee River Subbasin</u>

Within the Wenatchee River subbasin at least 25 randomly-located and 23 index reaches each 1.6-km long (1.0 mile) are surveyed throughout the spawning period (Moberg and Ward 2008). The WDFW usually initiates redd surveys in the lower river in response to water temperatures and adult steelhead migrating past Columbia River dams. Surveys generally begin March 1 based on previous years’ spawn timing. The use of index reaches may be problematic if there is a high degree of annual variation in the distribution of redds (Dunham et al. 2001), so a single survey is performed on the larger historical reaches where all redds are counted once at the end of the spawning season (Table 1). These surveys ensure that index reaches still represent core steelhead spawning and document how steelhead spawning is distributed.

Table 1. Wenatchee subbasin steelhead redds survey reaches and corresponding index areas.

Reach	Index area
Wenatchee River	
Sleepy Hollow Br. to Lower Cashmere Br. (W2)	Monitor boat ramp to Cashmere boat ramp
Leavenworth Bridge to Icicle Road Bridge (W6)	Leavenworth boat ramp to Icicle River
Tumwater Dam to Tumwater Bridge (W8)	Swift-water boat ramp to Tumwater Bridge
Tumwater Bridge to Plain (W9)	Tumwater Bridge to Plain
Plain to Lake Wenatchee (W10)	Chiwawa pump station to Lake Wenatchee
Peshastin Creek	
Mouth to Camas Creek (P1)	Kings Bridge to Camas Creek
Camas Creek to mouth of Scotty Creek (P2A)	Ingalls Creek to Ruby Creek
Camas Creek to mouth of Scotty Creek (P2)	FR7320 to mouth of Shaser Cr.
Ingalls Creek	
Mouth to Trailhead rm 1.0 (D1)	Mouth to Trailhead rm 1.0
Trailhead to Wilderness Boundary rm 1.5 (D2)	Trailhead to Wilderness Boundary rm 1.5
Chiwawa River	
Mouth to Grouse Creek (C1)	Mouth to Road 62 Bridge rm 6.4
Grouse Creek to Rock Creek (C2)	Chikamin Creek to Log jam
Clear Creek	
Mouth to HWY 22 (V1)	Mouth to HWY 22
HWY 22 to Lower culvert rm 2.0 (V2)	HWY 22 to Lower culvert
Nason Creek	
Mouth to Kahler Creek Bridge (N1)	Mouth to Swamp Creek
HWY 2 Bridge to Lower R.R. Bridge (N3)	Highway 2 Bridge to Merrit Bridge
Lower R.R. Bridge to Whitepine Creek (N4)	Rayrock to Church camp
Icicle River	
Mouth to Hatchery (I1)	Mouth to Hatchery
Little Wenatchee River	
Mouth to Lost Creek (L2)	Fish Weir to Lost Creek
Lost Creek to Rainy Creek Bridge (L3)	Lost Creek to Rainy Creek Bridge
White River	
Sears Cr. Bridge to Napeequa River (H2)	Riprap bank to Napeequa River
Napeequa River to mouth of Panther Creek (H3)	Napeequa River to Grasshopper Meadows.
Napeequa River	
Mouth to rm 1.0 (Q1)	Mouth to rm 1.0

Entiat River Subbasin

The Mad River index reaches are surveyed from the confluence with the Entiat to RK 11.3. Increasing water temperatures toward 40C and increasing flows (as measured by the Department of Ecology at https://fortress.wa.gov/ecy/wrx/wrx/flows/station.asp?sta=46C100) determine when to initiate redd surveys. Index reaches were designed to include sections of river with known steelhead spawning and to be accessible from the road to conduct foot surveys. Index site 3 (Fox Creek) is located from Fox Creek to just past the adult spawning channel. Index site 2 (Dill Creek) is from Dill Creek to Chelan Douglas Land Trust property. Index site 1 (Keystone Site) is from Keystone Gage station to the Entiat River mouth.

In the Entiat River subbasin, a total count is conducted in the mainstem Entiat River from RK 0.3 near the mouth of the river to RK 41.8. Weekly or biweekly surveys begin in the lower river when water temperatures are > 4.0^0C and spawning has commenced in the downstream section of the river (Section A: Entiat Hatchery to confluence with Columbia River, **Error! Not a valid bookmark self-reference.**). Surveys generally begin by March 15, but may be delayed by water or weather conditions. In 2005, reach designation was changed to accommodate the increased survey area intended for surveys of the Entiat River watershed (Table 3). The river was divided into reaches of river that can be rafted in one day and are labeled by letters starting with “A” near the confluence and moving upstream. Within the reaches are nested index and secondary sections. Redds and fish should be tallied by reach and section.

Table 2. Entiat River Steelhead redd survey sites by river kilometer and site type.

Survey site Number	Site type	Site location river kilometer
1	Index	41.8- 43.1 and 43.7 - 44.2
4	Index	30.0 - 34.1
8	Index	1.1 - 2.5
D	Extended	37.7 - 41.8
C	Extended	25.9 - 37.7
B	Extended	10.6 - 25.9
A	Extended	2.5 - 10.6

Table 3. Steelhead redd survey reach designation within the Entiat River.

Reach	Section name	Downstream location	Upstream location
A		Last riffle near Kiosk	Entiat Hatchery outflow
A	Keystone – **Index**	Last riffle near Kiosk	Keystone Gage pool
A	Firehouse run	Keystone gage pool	Firehouse bridge
A	Bridge to Bridge	Lower highway bridge at firehouse	Upper highway bridge
A	Hatchery run	Dinkelman Canyon Bridge	Hatchery
B	McKenzie reach	Hatchery	McKenzie diversion
B	Mad River Down	Hatchery	Mad River
C	Stillwater	McKenzie diversion	Brief Bridge
C	Chinook # 5	McKenzie diversion	Chelan Douglas Land Trust
C	**Index,** Chinook #4-	Chelan Douglas Land Trust	Foss Bridge
C	Chinook # 3	Foss Bridge	Brief Bridge
D	Chinook # 2	Brief Bridge	Forest Boundary sign
D	Spawning channel **– Index**	Forest Boundary sign	Spawning channel
D	Box to Fox	Fox Creek Campground	Box Canyon
E		Box Canyon (Fishtail Falls)	Entiat Falls
E	Tommy Bridge	Box Canyon (Fishtail Falls)	Tommy Bridge
E	Entiat Falls	Tommy Bridge	Entiat Falls

Procedures:

Step 1: Locate and establish area to be surveyed using the Site Selection protocol (Moberg and Ward 2008).

Step 2: On the Reach Dataform (Appendix B) record the survey date, the reach ID, start time, start water temperature (Cº). Upon completion of the survey record the end time and end water temperature (Cº). Then record the GPS locations of the top and bottom of the reach on the Reach Dataform (Appendix B) including the EPE (estimated precision error) associated with each recording. Record all GPS locations in WGS84, decimal degrees. Also for each survey record the following:

- The weather at the time of the survey as (W)indy, (C)loudy, (S)unny, or (R)ainy. Also characterize the clarity of the water as (1) good, (2) adequate, or (3) poor.
- Using GPS and photos document the presence of any chutes or falls greater than 1 meter in height (potential barriers to anadromy). Document the presence of any chutes or falls greater than 1 meter tall. Record on the Reach Dataform the chute/falls GPS location, its height and length, and the gradient. Take photographs of the chute.

Step 3: Once the reach has been established, survey the reach on foot or using a raft. Foot surveys can be conducted either walking upstream or downstream. To avoid disturbing spawning fish walking upstream is the preferred method. On the datasheet record which method, walking or rafting, is utilized and in what direction surveys are conducted. Polarized sunglasses should be worn while conducting surveys to reduce surface water glare and allow for the optimal viewing of redds. Surveys should then progress looking for disturbed substrate.

Step 4: Upon finding disturbed substrate:

- Determine and record if disturbed substrate is a (P)ossible, p(R)obable, or (D)efinite redd. Probable or definite redds show a distinct pit or pot and a tailspill. Possible redds (test digs or stream scouring hydraulics) are revisited on the next survey to determine if redd has further developed into a probable or definite redd.

- For probable or definite redds assess if fish are present. If fish are present record fish estimated length, sex, life stage, and presence/absence of an adipose fin on datasheet.

- Record the location of individual redds using GPS. If possible, record the EPE associated with the GPS reading.

- Record on the Redd Dataform for probable and definite redds the condition of the redd as (I)ncomplete, (C)omplete, (F)aded, or (E)rased (Table 4). An incomplete redd is a disturbance that doesn't have defined pit and tailspill but which is not caused by hydraulics.

- Measure and record the length and width of the redd in meters. If the redd is oddly shaped take several measurements of length and width and use the average.

- Flag the upstream edge of the redd with flagging tape denoting the reach letter or ID, redd number, date, observer initials, and the location of the redd in the stream. The location of the redd is the distance (m) and direction (compass set to 0 declination) from the flagging to the redd. Each redd must be labeled consecutively to ensure that they are not counted as a new redd during subsequent surveys.

- When encountering a previously flagged redd record the condition of the redd and measure the length and width (m) to determine if the redd is larger then previously measured.

- Once a redd is determined to be erased, no further observations are necessary.

Step 5: Draw a site map depicting the relative location of redds during each survey. Label each redd on the map. Include the direction of flow and relative distance of the redd to objects such as logs and large rocks on the map. A good map will reduce uncertainty if redd flagging is missing. Continue the survey and repeat steps 3 and 4 for each redd surveyed.

Step 6: Repeat the survey weekly or biweekly throughout the spawning period. Relocate previously recorded redds using the maps, GPS, and flagging used to identify redds.

Record the condition of each previously recorded redd and note if steelhead are present. When observing a previously identified redd, note if a steelhead is present. Also measure and record the length and width of the redd during each survey. New redds are numbered sequentially as they are discovered. If it is discovered that flagging is missing, relocate and flag the redd using the GPS location for that redd.

Step 7: Surveys will continue until mid-June or until no new redds have been identified for two consecutive surveys. If after two consecutive surveys, no new redds are found in the survey area, surveys will be concluded in that area. Remove flagging during the final visit or conduct a designated trip to remove flagging.

Table 4. Criteria for describing visible life (condition or cover) of a steelhead redd.

Code	Redd cover	Description
I	Incomplete redd	Not well developed redd and fish on redd
C	Complete redd	Well developed pit and tailspill
F	Faded redd	Redd fading, algae and or redd flattening out but still visible
E	Erased redd	Area not identifiable as a redd

Section 4: Data Management

Data management framework

The ISEMP Data Management effort is designed to develop standardized tools and procedures for the organization, reduction, and communication of monitoring data and methods within ISEMP pilot basins located in the Wenatchee and Entiat subbasins, WA, John Day, OR, and Salmon River, ID. Beginning in 2004, a pilot project has been under development aimed at integrating four primary data management tools: Automated Template Modules (ATMs), the Status Trend and Effectiveness Monitoring Databank (STEM databank), Protocol Editor (PE), and the Aquatic Resources Schema (ARS). The STEM Databank is the central data repository for the ISEMP project. It was developed by the Scientific Data Management Team at NOAA-Fisheries to: (1) accommodate large volumes of data from multiple agencies and projects; (2) summarize data based on how, when, and where data were collected; (3) support a range of analytical methods; (4) develop a web-based data query and retrieval system, and (5) adapt to changing requirements. This fully-normalized database structure allows the incorporation of new attributes or removal of obsolete attributes without modification of the database structure. Data can be summarized in a variety of formats to meet most reporting and analytical requirements.

Successful data management systems require a user interface that is intuitive to the user and that increase the efficiency of the user's workflow. The Automated Template Modules (ATMs) are a collection of forms that allow users to enter and view data in a format that is familiar to biologists. Each ATM has forms for entering new data, reviewing existing data, and updating existing data. Additionally, each ATM has a switchboard to help guide the user to the correct forms.

The general layout of the forms includes a header section to display information about the data collection event and a series of tabs that display detailed observational data. The header section describes the general characteristics about when, where, and how the data was collected or observed. The header section always includes the site, the start date and time, and the protocol. Additionally, the header section may include general characteristics about the sampling reach or unit, environmental conditions, weather conditions, water temperature and visibility, presence of fish, and protocol deviations. A series of tabs below the header section display detailed observations that occurred during the data collection event in spreadsheet format. Tabs vary between the different ATMs, but typically include a tab for crew and for equipment.

Data entry forms perform the critical function of validating data at the time of data entry. For categorical attributes, users are only allowed to select from acceptable categories as defined by the protocol. Similarly, values entered for continuous attributes are checked to ensure values are within the expected range. Data entry forms are "protocol aware". The database includes tabular data that specifies details about the protocol. All categorical fields on data entry forms have pull-down lists that limit the values a user can enter for the field. The pull-down lists reference the protocol documentation tables and only display values that are defined for the active protocol. Similarly, for continuous values, the forms check the expected range as defined in the protocol and warn the user if the entered value falls outside of the expected range. Users can choose to modify the value or accept the value as it was entered. The use of "soft" bounds on continuous values is an effective validation strategy for ecological data, where data often follows a normal distribution with long tails as opposite to a discrete distribution common to financial data.

Protocol Editor is a data dictionary, user-friendly tool for describing the list of all attributes collected by a given protocol that includes a description of the data type, units of measure, number of characters or digits, number of decimal places, and list of acceptable values for all attributes collected by a protocol. Protocol Editor allows the ATM to be calibrated to a given protocol and allows the ATM to ensure consistency between the protocol and the data entered for that protocol. Protocol Editor follows the same rules established by Protocol Manager (a protocol documenting tool being developed by USBOR). A protocol is defined as a collection of methods, where each method consists of the list of attributes to be recorded by the data collector. The name of attributes is restricted to attributes defined by the ARS; however, users are allowed to create an alias name for the attributes. Metadata entered into Protocol Editor can easy be exported in a tabular format for importing into Protocol Manager.

The ARS is the collection of database tables that store data entered into the ATM forms. The ARS was developed to support agencies within the Columbia River Basin manage, document, and analyze aquatic resources data. The ARS aims to define a standardized data structure for storing and processing water quality, fish abundance, and stream habitat data. The ARS is robust against variations between data collection protocols, supports procedures for increasing data integrity at the time of data entry, and supports proper analysis and summarization of aquatic resources data.

Data handling

Data should be entered into the ATM provided by ISEMP on a regular basis by the data collectors and should undergo QA/QC before being sent to the Upper Columbia Data Steward for uploading into the STEM Databank.

Data Analysis

This section is under development by the ISEMP data analysis team and will be included in the next revision of this working draft.

Data reporting

The data collection agencies are responsible for preparing an annual report that will follow the outline below covering the redd survey period:

1. Brief abstract (limit 600 words).

2. Standard introduction provided by ISEMP plus brief description of specific project(s) covered in report.

3. Concise description of project area/map.

4. Description of methods and materials used to perform tasks.

5. Summary of results (number of redds seen, dates of surveys etc) and brief discussion of results by task (problems encountered, suggestions for future work).

6. If necessary, supplemental electronic copies of summarized field data in spreadsheet or GIS format.

The annual report shall be submitted to the BPA Project Manager/COTR and the ISEMP coordinator. Guidelines for preparing the report can be found at http://www.efw.bpa.gov/Integrated_Fish_and_Wildlife_Program/ReportingGuidelines.pdf. The Upper Columbia Data Steward is responsible for generating an annual report to the Watershed Action Teams, Project Sponsors and monitoring agencies that will include a summary of the number of redds counted each year by tributary and subbasin.

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Appendix A: Attribute Table

This section is under development by the ISEMP Data management Team and will be included in the next revision of this working version.

Appendix B: Dataforms

Datasheet 1: Example of an individual steelhead redd dataform.

2008 **Entiat River Steelhead Redd Surveys** Page #

Survey description:

Redd #		Location:							
Date									
Depth									
Width									
Length									
Condition									
Activity									
Redd #		Location:							
Date									
Depth									
Width									
Length									
Condition									
Activity									
Redd #		Location:							
Date									
Depth									
Width									
Length									
Condition									
Activity									

Datasheet 2: Example of a reach dataform used in steelhead redd surveys.

Reach Data Form

Survey Date	Reach ID	X- Site Reach lat.	X-Site Reach Long.	Start Time	Start H2O temp	Weather Conditions	End H2O Temp	End Time	Rating	Comments
						W S C R			1 2 3	
						W S C R			1 2 3	
						W S C R			1 2 3	
						W S C R			1 2 3	
						W S C R			1 2 3	
						W S C R			1 2 3	
						W S C R			1 2 3	
						W S C R			1 2 3	
						W S C R			1 2 3	
						W S C R			1 2 3	
						W S C R			1 2 3	
						W S C R			1 2 3	
						W S C R			1 2 3	
						W S C R			1 2 3	
						W S C R			1 2 3	
						W S C R			1 2 3	
						W S C R			1 2 3	
						W S C R			1 2 3	
						W S C R			1 2 3	
						W S C R			1 2 3	
W= windy, S=sunny, C = cloudy, R= Rainy Partly cloudy circle both sunny and cloudy										
Rating - 1= good water clarity (good), 2= reduced water clarity (adequate), 3= poor water clarity (poor)										

Datasheet 3: Example of dataform used it map location of redds.

Redd # 's	Redd Map	Page #

Appendix C: Equipment check list for steelhead redd surveys

Raft trailer

- ☐ Check lights
- ☐ Tie down straps
- ☐ Secure all gear

10 ft Sotar raft

- ☐ GPS
- ☐ Wading stick
- ☐ Flagging tape – Pink
- ☐ Thermometer
- ☐ Oars – 3
- ☐ Pump
- ☐ Repair kit
- ☐ First Aid kit
- ☐ Saw
- ☐ Screw driver
- ☐ Black permanent marker
- ☐ Pencil

Personal gear

- ☐ Waders
- ☐ Boots
- ☐ PFD
- ☐ Throw bag
- ☐ Repair kit
- ☐ Polarized glasses
- ☐ Billed hat
- ☐ Sunscreen
- ☐ Personal field notebook
- ☐ Food and water
- ☐ Raingear and extra clothes
- ☐ Digital camera
- ☐ Field notebook for redd surveys
- ☐ Sat Phone

Green Outcast raft

- ☐ GPS
- ☐ Wading stick
- ☐ Flagging tape – Pink
- ☐ Thermometer
- ☐ Oars – 3
- ☐ Repair kit
- ☐ First Aid kit
- ☐ Saw
- ☐ Black permanent marker
- ☐ Pencils

Collection permits

- ☐ WDFW
- ☐ USFWS
- ☐ NOAA-Fisheries

Truck gear

- ☐ Flagging tape – Pink
- ☐ Black permanent marker
- ☐ PFD- spare universal
- ☐ Throw bag -spare
- ☐ Pencils
- ☐ Extra strap

Appendix D: Protocol Revision Log

As new information becomes available and steelhead redd monitoring efforts are refined, the protocol will be revised. Effectively tracking past and current protocol versions are important for data summaries and analyses that utilize data collected under different protocol versions. Protocol Editor will house previous and current protocol versions and the dates of their implementation. Reviews will be performed for all proposed changes to the protocol and the Upper Columbia Data Steward notified so the version number can be recorded in the project metadata and any necessary changes can be made to database structure (Peitz et al. 2002). Consistent with the recommendations of Oakley et al. (2003) this protocol includes a log of its revision history. The revision history log (adapted from Peitz et al. 2002) will track the protocol version number, revision dates, changes made, the rationale for the changes, and the author that made the changes. Revisions or additions to existing methods will be reviewed by ISEMP staff prior to implementation. Major revisions such as a complete change in methods will necessitate a broader review by outside technical experts. When the protocol warrants significant changes the protocol version and date on the title page should be updated to reflect the new version. Version numbers should increase incrementally by hundreths (e.g., Version 1.01, 1.02 etc.) for minor changes and by the next whole number (e.g., version 2.0, 3.0 etc.) for major changes (Peitz et al. 2002).

Protocol Revision History Log

Previous Version #	New Version #	Revision Date	Author	Changes made	Reason

(adapted from Peitz et al. 2002)